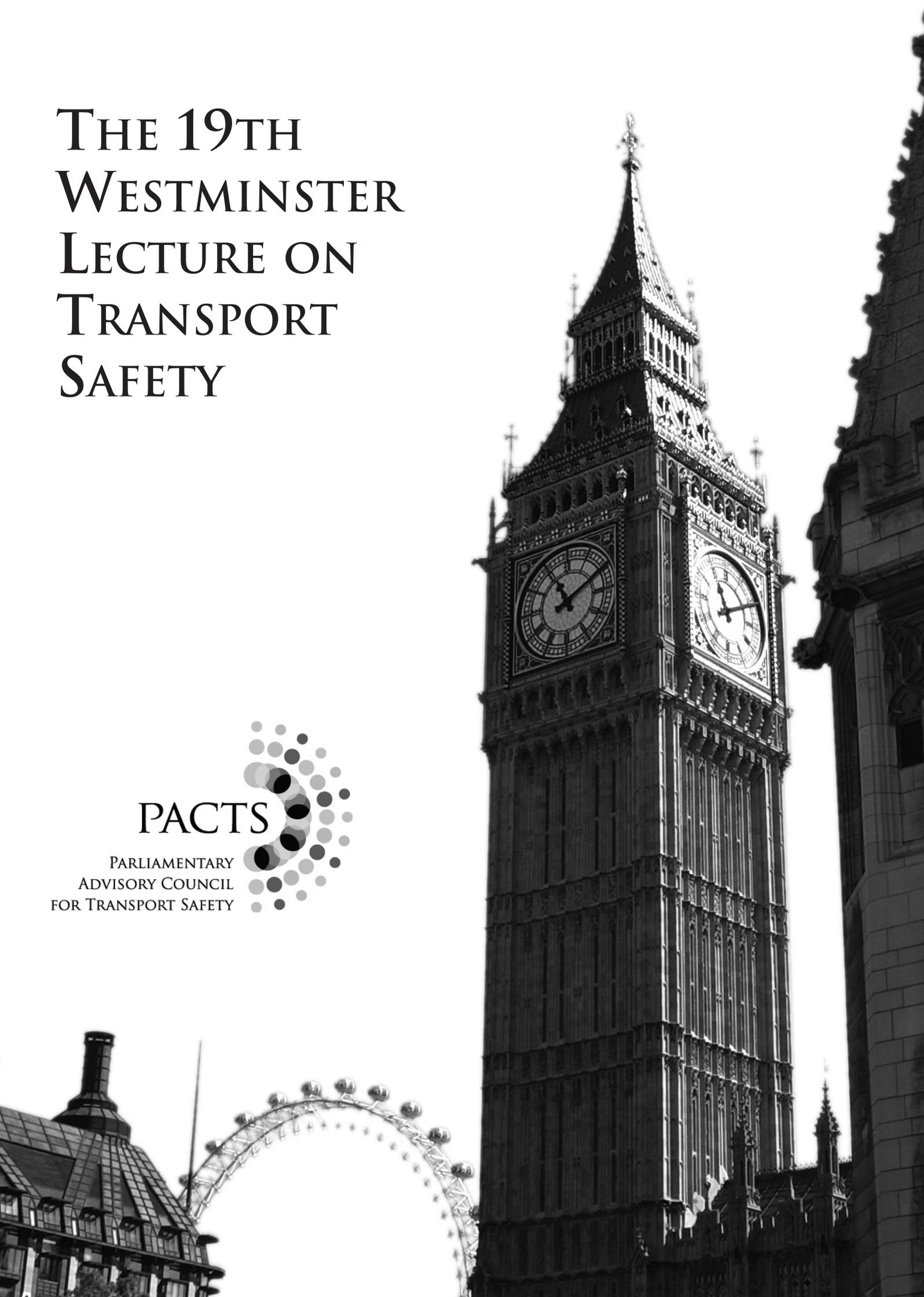


# THE 19TH WESTMINSTER LECTURE ON TRANSPORT SAFETY

PACTS

PARLIAMENTARY  
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FOR TRANSPORT SAFETY



# ABOUT THE LECTURER

OLIVER CARSTEN

Oliver Carsten is Professor of Transport Safety at the Institute for Transport Studies, University of Leeds. His main area of research is on the interplay between new technology and road user behaviour. He has focused both on the potential problems that can be caused by new systems, examining for example the impact of driver distraction on driving performance and safety, and on the potential of technologies to deliver new ways of tackling safety problems. He is Chair of the PACTS Road User Behaviour Working Party.

## TECHNOLOGY: CURSE OR CURE?

19TH WESTMINSTER LECTURE ON TRANSPORT SAFETY

## WHY TECHNOLOGY?

Technology is having an unavoidable and fundamental impact on driving and as a consequence on traffic safety. The vehicle fleet, with the possible exception of motorcycles, has been undergoing more rapid change in design than at any time since the invention of the automobile, and the rate of change is accelerating. Almost all the major recent developments in vehicle systems have been electronic, and it is estimated that by 2010 40% of a vehicle's cost base will be in the electrical system and vehicle electronics (Vehicle Electronics, 2008). These changes affect not only vehicle handling and primary safety (crash avoidance) but also secondary safety (injury protection) in the form of airbags, seatbelt pretensioning and other systems. We also have massive growth in GPS-based Personal Navigation Devices such as TomTom with 18 million units sold across Europe in 2008. Technology creates enormous new potential for the engineer and designer — systems can be linked to each other; car companies are starting to consider personalised vehicles, and we can create single interfaces to all the electronic systems that are under the control of the driver as with BMW's iDrive.

In terms of active safety and driver assistance systems the calendar for the past four decades has been:

1971: ABS, which prevents wheel lock-up to maintain friction between wheel and road surface

1995: Electronic Stability Control (ESC), which maintains directional controllability through brake intervention

1999: Adaptive Cruise Control (ACC), which replaces the driver in the car following task by driving at a set headway

2000: Lane Departure Warning

2005: Blind Spot Warning to assist in lane changing

2006: Lane Keeping System, which applies corrective steering responses to steer the vehicle back into lane

2006: Forward Collision Warning

2007: Forward Collision Warning with automatic braking — the vehicle intervenes if the driver does not react

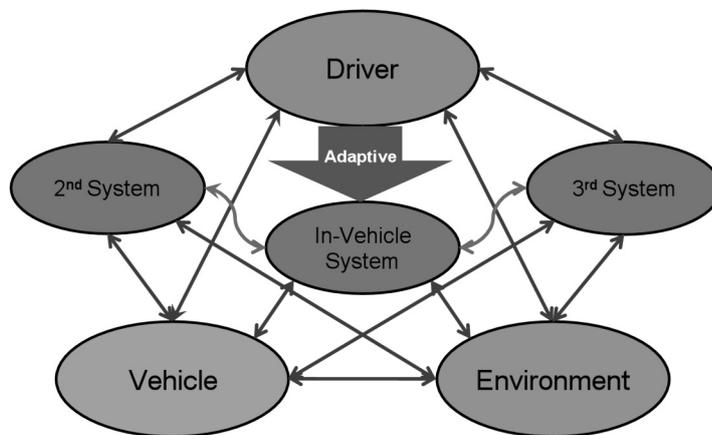
2007: Stop and Go, which extends ACC to stop and start traffic

The vehicle manufacturers are not lacking in scale of ambition for these new systems. Daimler has a vision of “accident-free driving in the 21st century”, with new active safety systems delivering much of that protection (Daimler, 2008). Volvo has a vision of cars that do not crash and “in the shorter perspective the aim is that by 2020 no-one should be killed or injured in a Volvo” (Volvo, 2008). And Nissan has developed an “All-Around Collision Free” prototype car featuring a variety of new active safety systems (Traffic Technology Today, 2008).

There are lots of visions of the future. One is of a large number of autonomous systems on board the vehicle, where “autonomous” does not mean that the systems do not collaborate with each other, but rather means that the vehicle is mainly operating independently of support from the infrastructure and from other vehicles in the traffic stream. An alternative vision is of a cooperative future in which vehicles are integrated into the road environment and with other traffic through infrastructure-to-vehicle (I2V) and vehicle-to-vehicle (V2V) communications.

Whatever the future, it will be electronic and involve multiple Advanced Driver Assistance Systems (ADAS). The driving task is being fundamentally altered by the advent of these new systems. Traditionally, the driving task has been represented as involving interaction between the driver, the vehicle and the road and traffic environment. But with new ADAS systems many more interactions are required, as shown in Figure 1:

- A system may adapt to a driver's driving style or current performance;
- The systems may communicate with each other;
- The driver has to anticipate and respond to the behaviour of several systems;
- The driver may have to interact with an in-vehicle “manager” or “supervisor” of those systems;
- And at the same time the driver must still anticipate and respond to the road and traffic environment.



**Figure 1: Interaction between driver, vehicle and environment as well as with multiple systems**

The vehicle designer is faced with some rather difficult alternatives. The systems can be “hidden”, but in that case the driver may fail to understand what the systems are doing. On the other hand, there can be full transparency of all the systems with multiple screens and messages, but that may lead to high workload and driver stress. In the automotive environment, there has been remarkably little research in this important area. Thus we do not know how drivers will respond and cope in this brave new world, still less do we know what are the optimal design choices.

The thought may occur that other transport modes, and in particular commercial aviation, have grappled with the same problems. It is true that semi and fully automated flight has been commonplace in aviation for several decades, and that there has been extensive research on the human factors consequences of these new systems. But it is not sensible just to lift experiences from the aviation domain and apply them to road transport. There are some major contrasts between the two domains. The commercial aviation environment is highly structured, has relatively

few actors, has only professional operators and has a trained team in the cockpit. By contrast, in road traffic we have a far greater mix of equipment, we are not dealing primarily with professional and fleet operators, we do not have a trained team in the cockpit, there is far greater situational complexity and far more variety in traffic situations, and last but by no means least critical events have far shorter time frames (in fractions of a second as opposed to seconds and minutes). Thus, as we introduce increased automation in driving, we should be very wary of lifting solutions from the aviation sphere. The road domain must learn its own solutions.

# DISTRACTION

## THE PROBLEM

Driver distraction from the primary task of driving is one of the unfortunate consequences of the introduction of new systems into the vehicle. That distraction can be caused by the use of devices that have nothing to do with driving, such as mobile phones being used for non-driving-related tasks, by so-called "nomadic" (i.e. portable) devices such as aftermarket SatNav systems and also by systems fitted by vehicle manufacturers. The degree of distraction is a function of the driver's willingness to engage in distracting tasks, of the task being performed and of the quality of the system design and interface. The impact of the distraction in terms of driving is related to driver capability and of the current situation at any moment.

Distraction is by no means a new problem as the following quotation from 1930 illustrates:

A grave problem that developed in New Hampshire, spread to Massachusetts, and crept over to Albany, now has all the motor-vehicle commissioners of the eastern states in a wax. It's whether radios should be allowed on cars. Some states don't want to permit them at all — say they distract the driver and disturb the peace. The manufacturers claim that the sound of Rudy Vallee's voice is less disturbing than backseat conversation. Massachusetts leans toward the middle of the road. The commissioner there thinks the things should be shut off while you are driving, but that you should be allowed to take culture with you into the wilderness. The whole problem is getting very complex, but the upshot is that you'll probably be allowed to take your radio anywhere, with possibly some restriction on the times when you can play it. (Probably from the *New Yorker* magazine and quoted in Goodman et al., 1997, p.17)

So concern with new in-vehicle technologies causing driver distraction goes back a long way. But can we really claim that the problem is better managed now than in the 1930s? We certainly know quite a lot about dangerous behaviours such as texting while driving, but we have not been all that successful in outlawing those behaviours. And use of mobile phones can cause transport accidents in other modes than road. On 12 September 2008 in Los Angeles a train loaded with commuters crashed into a freight train after running a red signal, killing 25 people and injuring 135. It has been reported that the driver had been texting 22 seconds before the crash and had received a text message a minute earlier (Reuters, 2008). It is interesting to note that texting by vehicle drivers was banned by law in California, but texting by train drivers was not.

That distraction while driving is a genuine safety problem has been confirmed by the so-called 100 Car Study conducted by Virginia Tech (Dingus et al., 2006). In this study, 100 highly instrumented cars were driven in "naturalistic" circumstances for a year in Virginia. There was a particular focus on young drivers among the participants. Crashes (mostly damage-only), near-crashes and other incidents were identified and characterised by means of video analysis. Almost 80% of the crashes and 65% of near-crashes involved the driver looking away from the forward roadway just prior to the onset of conflict. Inattention, including secondary task distraction, was a contributory factor in 93% of the incidents with lead vehicles. It was also observed that the rate of inattention-related incidents decreased dramatically with age, thus indicating some of the problems of elderly drivers. Phone and PDA use was a major factor in the incidents.

## THE FINDINGS OF THE HASTE PROJECT

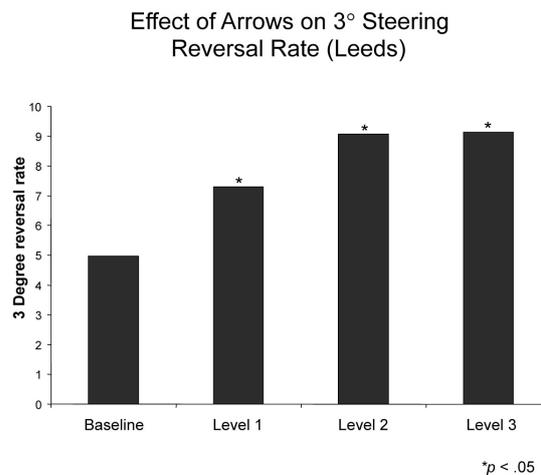
HASTE was a European collaborative research project on distraction that ran from 2002 to 2005 (Carsten et al., 2005). The acronym stood for Human Machine Interface And the Safety of Traffic in Europe, and the project was coordinated by ITS, Leeds. The objective of HASTE was to provide a test regime for the assessment of In-Vehicle Information Systems (IVIS) which:

- Was technology-independent, i.e. does not depend on a particular technology being employed in a system design;
- Had safety-related criteria;
- Was cost effective;
- Was appropriate for any IVIS system; and
- Was validated through real-world testing.

The methodology applied by HASTE was to start by going back to basics and examining the effects of distraction on driving performance. This was done by looking at the relationship between dose (distraction) and response (driving as well as some subjective measures). Two kinds of distraction were distinguished: visual distraction, where task difficulty was manipulated through a less or more demanding visual search task on a screen; and cognitive distraction, where task difficulty was manipulated by requiring participants to memorise a number of target sounds (fewer or more) as well as the order in which they had been presented and subsequently to identify those targets when mixed with other sounds.

These tasks were performed while driving both in a variety of simulators and on real roads (the highest level of “dose” was not administered in real-road driving). This very large set of experiments allowed us to identify the best performing indicators as well as the best performing test environment. We then applied the candidate set of indicators in an assessment of real systems, and, based on the outcome of this second set of trials, we proposed a draft test regime.

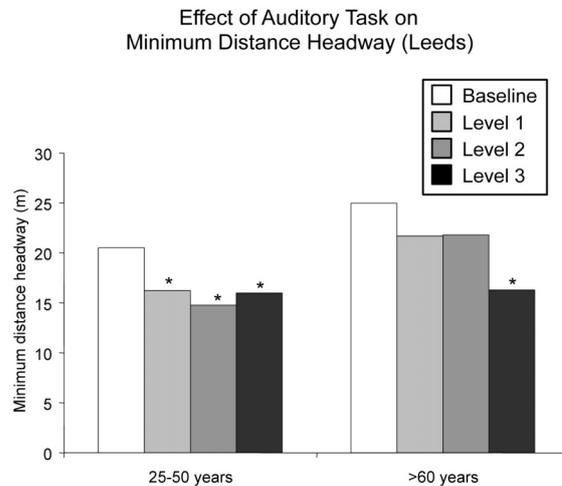
From the first set of experiments, we were able to identify major differences in the impacts on driving between the two types of distraction — visual and cognitive. Visual distraction, which leads to eyes off the road, had a particular impact on lateral control of the vehicle. This effect can be seen in Figure 2, which shows the effect of increasing visual distraction (from none in the baseline up through three different levels) on one kind of steering parameter, namely the driver’s propensity to reverse the direction of the steering wheel, as observed in the Leeds driving simulator.



**Figure 2: Effect of visual distraction on steering reversal rate**

By contrast, cognitive distraction primarily had an impact on longitudinal control of the vehicle. This is illustrated in Figure 3, which shows the effect of three levels of cognitive distraction against the baseline of no distraction. Here the indicator is minimum distance headway. Two groups of drivers

are distinguished: a younger group aged 25 to 50 and an older group aged 60 and over. For the older drivers there is a clear tendency for headway to decrease with increased cognitive load. For the younger drivers, there is the same tendency, but there is also a “plateau” effect. They appear to realise that it is not appropriate to engage in the most demanding task, while the older drivers do not appear to have the capacity to make that judgement.



**Figure 3: Effect of cognitive distraction on minimum headway**

We also observed that steering behaviour “improved” with higher cognitive load — there was less lateral deviation. Our partners at Volvo Technology carried out a detailed analysis of driver eye movements, and they found that at higher levels of cognitive distraction there was lower dispersal of gaze around the road scene. Instead there was increased focus on the road straight ahead. Thus it can be argued that the drivers are to some extent emulating their eye point in their steering activity. In all likelihood the apparent improvement in lateral control is the result of gazing at the road ahead with reduced information processing — in other words looking but failing to see.

The final outcome of HASTE was a draft test regime for IVIS. The regime’s features were:

- Driving in at least a medium-level driving simulator with a relatively small number of subjects (15 subjects were thought to be sufficient);
- A rural two-lane road driving situation and a duration of approximately one hour;
- Assessment needs to take place at the level of specific tasks on the IVIS, since an IVIS may have a combination of comparatively easy and relatively harder tasks;
- A small number of dependent variables (indicators) is sufficient. A set of six indicators was provisionally recommended.

The message from HASTE is that we do not lack the tools to evaluate new SatNavs and other In-Vehicle Information Systems in terms of their impact on driving quality. A relatively small effort would be required to go from the HASTE results to a test protocol that could be used by independent test laboratories to rate such systems for safety just like EuroNCAP rates new cars for occupant and pedestrian protection. At that moment, the market would take over: once systems were badged with a star rating for safety performance, we could be assured that good quality systems would drive the poorer ones off the market.

# SPEED AND INTELLIGENT SPEED ADAPTATION

## SPEED

It is not very surprising that one focus of new technology application in driving has been on speed compliance. Speed is a major factor in increasing the risk of accident occurrence and the severity of crashes should they arise, and a number of reviews have quantified the relationship between the speed of traffic or of the individual driver and accident risk (e.g. Finch et al. 1994; Elvik et al., 2004). Driving too fast may not necessarily be the unique cause of an accident: apart from single-vehicle loss of control accident, it normally occurs in combination with other errors and problems. But, given an error, excess or inappropriate speed makes a crash much more likely as the outcome. The energy dissipated in a crash goes up with the square of speed, so that severe and fatal crashes are much more highly associated with speeding than are slight injury crashes.

At his Westminster Transport Safety Lecture in 2007, Jim Reason described his “Swiss Cheese” model in which severe accidents and disasters occur when there are holes in the defences that might prevent them and when in a given situation those holes align. The prevention of excess or inappropriate speed blocks up one set of holes, rather like placing some sliced bread between the slices of cheese. The in-vehicle technology for discouraging or preventing speeding is known as Intelligent Speed Adaptation (ISA).

## ISA TECHNOLOGY

The “standard” form of ISA involves using what is essentially an enhanced satellite navigation system. A GPS (Global Positioning System) receiver gives the vehicle its position which is then matched to road position from an on-board digital road map. This road map is identical to that used in a Sat Nav except that it is enhanced with information on speed limit for each road. There is an HMI (human machine interface) to inform the driver of the current speed limit and advise the driver when he or she is exceeding the limit. The information can also be linked to the vehicle’s drivetrain (engine management system and maybe the brakes) to provide an intervening ISA as opposed to a purely advisory one. The intervention may be overridable (sometimes then called voluntary ISA) or non-overridable (which is then often termed mandatory ISA).

Even talking about ISA as a rational solution to speed-related crashes causes consternation in some sections of the driving population and often in the press. Terms such as “Big Brother” and “Spy in the Sky” are introduced to give the misleading appearance that the U.S. GPS satellites could somehow spy on the positions and speeds of all the vehicles on UK roads at any one time, whereas in fact with GPS it is the receiver on the vehicle that is observing the position of the satellites. We are told that ISA, particularly intervening ISA, could not be acceptable to British motorists. And we are told that, with an intervening ISA system, drivers are bound to go on “autopilot”, and use the system not as a limiter but as a guide to the appropriate speed. Such propositions about acceptance of and behaviour with ISA can be tested by means of empirical research.

## THE CAR TRIALS IN THE UK INTELLIGENT SPEED ADAPTATION PROJECT

A main focus of the Department for Transport funded Intelligent Speed Adaptation project was on driver behaviour when driving a car equipped with a voluntary ISA system in everyday driving. It was the intention for the experience to be over a period of time sufficient for the drivers to get used to having ISA and treat it as a normal part of driving. A fleet of twenty vehicles was prepared for this purpose. They were modified Skoda Fabia Elegance 1.4 litre estates, and were fitted with a voluntary ISA that, when engaged, limited vehicle maximum speed to just over the fixed legal speed limit. In the period of the trials when ISA was available, it defaulted to being on (active) for roads whose speed limit was known, but could be overridden at will by kickdown on the throttle or by pushing a button on the steering wheel. An in-vehicle HMI showed the speed limit and system

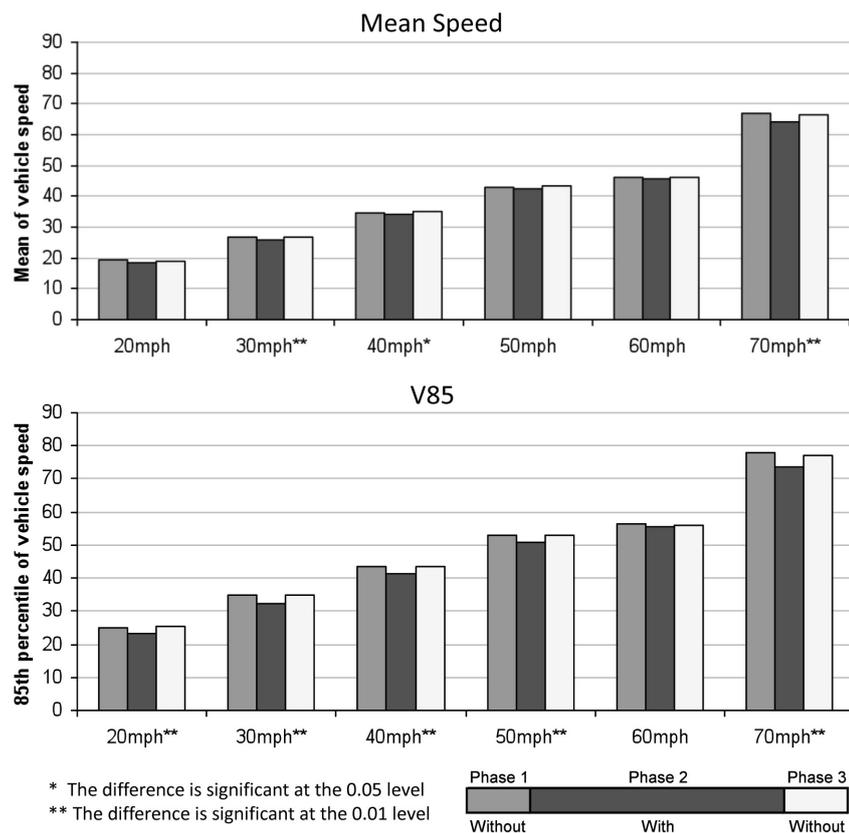
status, and the system beeped at changes in the speed limit. With ISA enabled, acceleration beyond the speed limit was curtailed, and a vibrator on the accelerator pedal discouraged the driver from demanding a grossly excessive speed. A data recording system was also incorporated.

Four successive trials of six months each were conducted. There were two trials in the predominantly urban Leeds area, one with private motorists, and one with fleet drivers. And there were two trials in a predominantly rural part of Leicestershire, again one with private motorists and one with fleet drivers. The first trial began early in 2004 and the last one was completed in mid-2006. In each case, the first month of driving was without ISA to provide a baseline. There then followed four months of driving with the ISA system available. In the last month the ISA was again disconnected, to enable study of carry-over effects.

Data was logged at 10 Hz. The total mileage covered by the 79 drivers who completed was 429,487 miles. Speed limit information was known for 354,592 miles, of which 218,790 miles were driven in the ISA-active phase. The participants were mixed in terms of gender, age and speeding intention.

## RESULTS: SPEED

Driving with ISA had a substantial impact on speed choice at the top end of the distribution. This can be seen from Figure 4, which shows the mean and 85th percentile speed of the drivers across all four trials. It can be seen that, while mean speed went down with ISA (Phase 2 of the trials) on most road categories, 85th percentile speed was affected more substantially.



**Figure 4: Mean and 85th percentile speed by trial phase and speed limit**

Figure 5 shows the speed distribution of the drivers when driving on 30 mph roads. The effect of driving with ISA was to substantially curtail high speeds and there was no discernible effect of the system on the distribution of speed at the lower end. This shows that drivers were not on ‘autopilot’. Because the drivers were able to override the system, there was still some driving above the speed limit. In Phase 3, when the ISA was withdrawn, behaviour reverted to that observed in Phase 1.

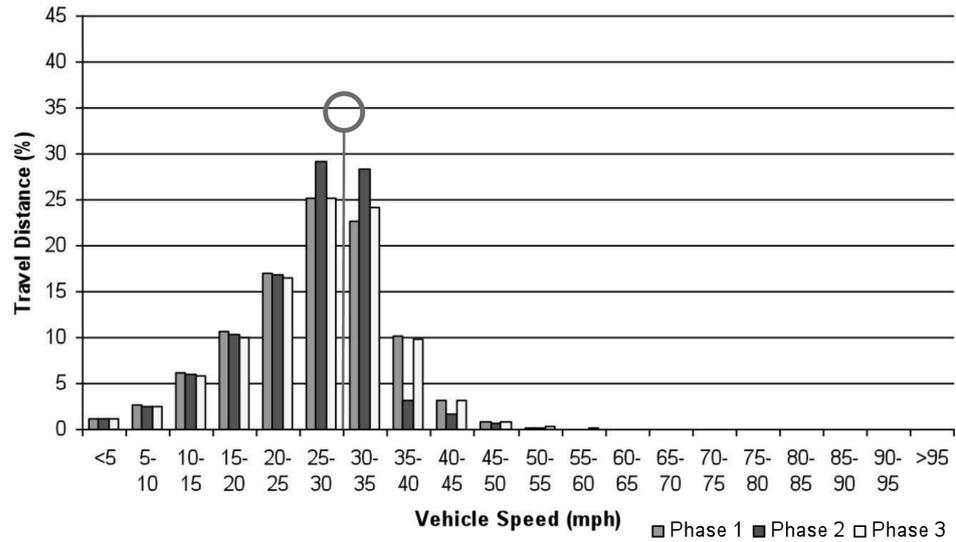


Figure 5: Speed distribution by trial phase on 30 mph roads

Figure 6 shows the same analysis for 70 mph roads. Again there was no real change at the low end, and again ISA curtailed very fast driving.

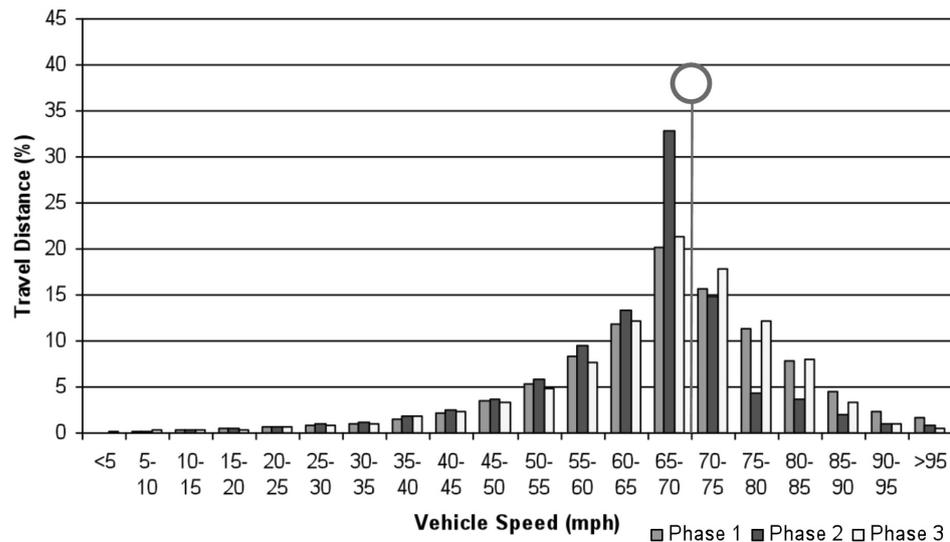
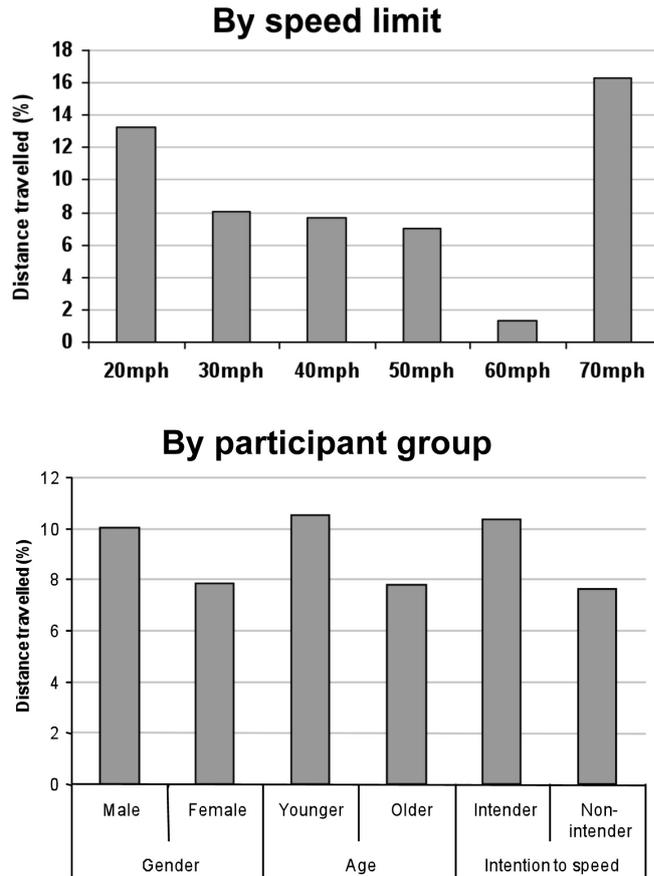


Figure 6: Speed distribution by trial phase on 70 mph roads

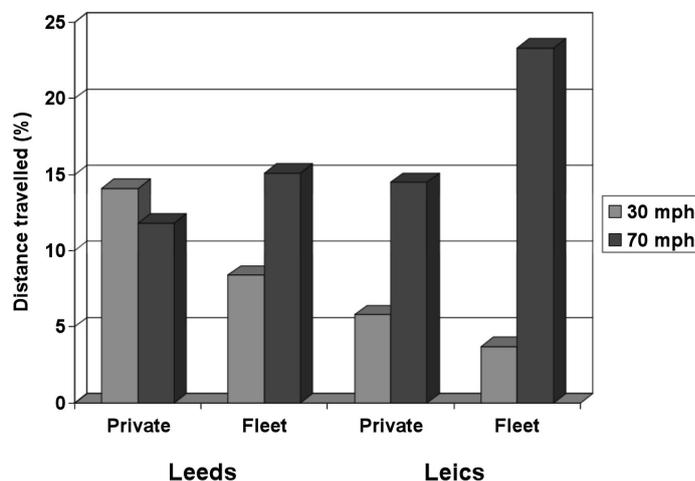
With a voluntary ISA, it is important to look at how the propensity to override the system varies by road class and driver group. Figure 7 shows the proportion of distance driven with ISA overridden during the period with ISA available. It can be seen that, in terms of speed limit, the greatest propensity to override was on 70 mph roads. This is not all that surprising in view of the general tendency of most car drivers to speed on such roads. More surprising is the amount of overriding on 20 mph roads. This is perhaps to be accounted for by a habit of drivers to speed between road humps and other pieces of restraining infrastructure. Since ISA interferes with that habitual behaviour, the drivers override it. It should also be noted that there was rather little driving overall on 20 mph roads.



**Figure 7: Proportion of distance driven with ISA overridden**

In terms of participant groups, the tendencies are as might be expected: male drivers overrode more than female drivers, younger drivers more than older drivers and speed-intenders more than non-intenders. However, the detailed analysis revealed that all groups had their tendency to speed moderated by having ISA in the car:

Figure 8 shows how the propensity to override the ISA system on 30 mph and 70 mph varied between the four trials. There was a pronounced tendency in both Leeds and Leicestershire for the private motorists to override more than the fleet drivers on 30 mph (urban) roads, whereas the fleet drivers overrode more than the private motorists on 70 mph roads (dual carriageways and motorways). Perhaps the fleets emphasised a duty to comply with speed limits on urban roads. And perhaps the fleet drivers were in more of a hurry on the 70 mph roads.



**Figure 8: Overriding of ISA on 30 mph and 70 mph roads by trial**

## RESULTS: ATTITUDES

The acceptability of ISA was investigated at four points during each trial — in the before period, early and late in the ISA-enabled phase and after ISA was withdrawn. The questionnaire used was one developed by Van de Laan et al. (1997) which measures usefulness (how good is it for the traffic system) and satisfaction (how much does it fulfil my goals). For both, the scale is from -2 (very negative) to +2 (very positive). The results are shown in Figure 9. As regards usefulness, there are indications (not statistically significant) that the early experience with the system decreased participants' appreciation of the usefulness of ISA as compared with their preconception, but that this appreciation increased with prolonged experience and continued at a high level even when the system was removed. Usefulness was rated quite positively overall. Ratings of satisfaction generally improved over time (statistically significant), following a slight dip at the beginning of driving with ISA. Satisfaction was highest after the removal of ISA support. It was also observed that speed intenders rated the ISA system as significantly less satisfying than did non-intenders. The participants' regret at losing ISA is noteworthy.

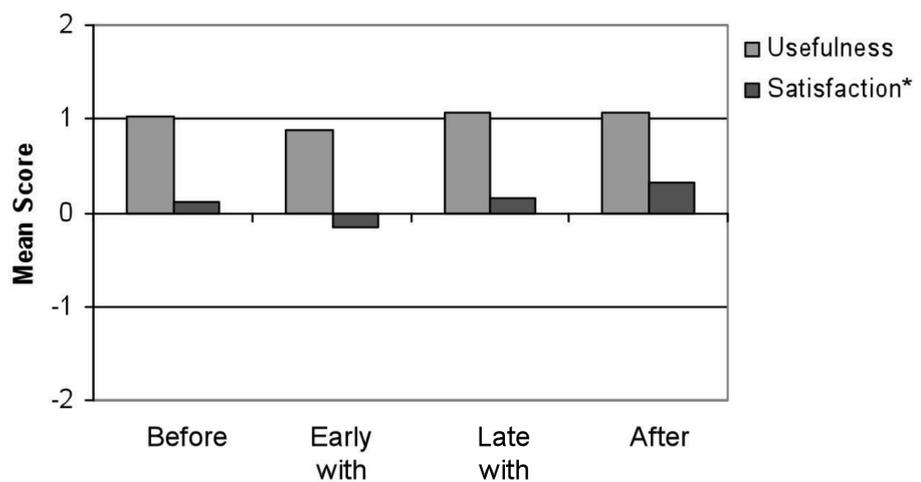


Figure 9: Acceptability of ISA

The Driver Behaviour Questionnaire (Parker et al., 1995) was used to ascertain the frequency with which individuals committed various types of errors and violations when driving. Three distinct types of aberrant driving behaviours were identified— errors, lapses and violations. The participants rated how often they had committed 24 distinct behaviours (0 = never; 1 = hardly ever; 2 = occasionally, 3 = quite often, 4 = frequently, 5 = nearly all the time). We thus obtained a self-reported measure of changes in error rates over the six-month trial period. The results are shown in Figure 10. Each type of aberrant behaviour declined over time and continued to decline after ISA was removed. Thus experience with ISA apparently reduced all error types, including the most serious.

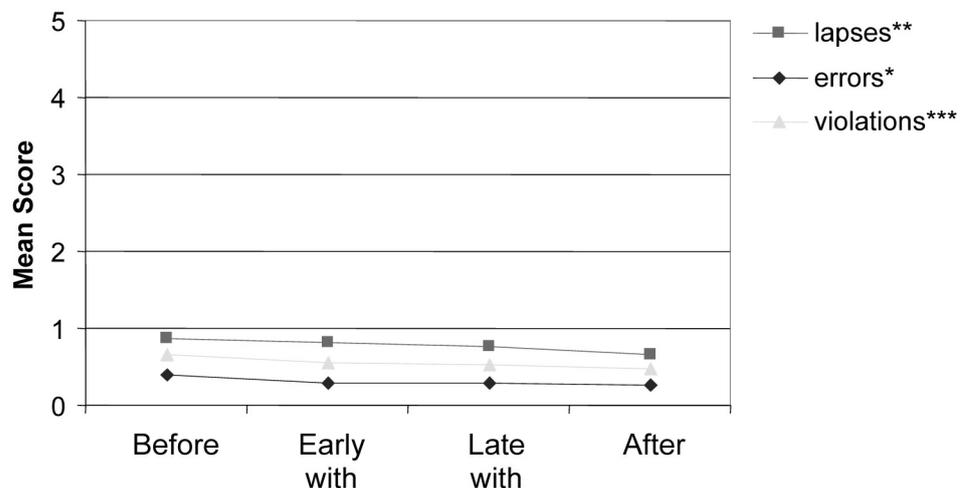
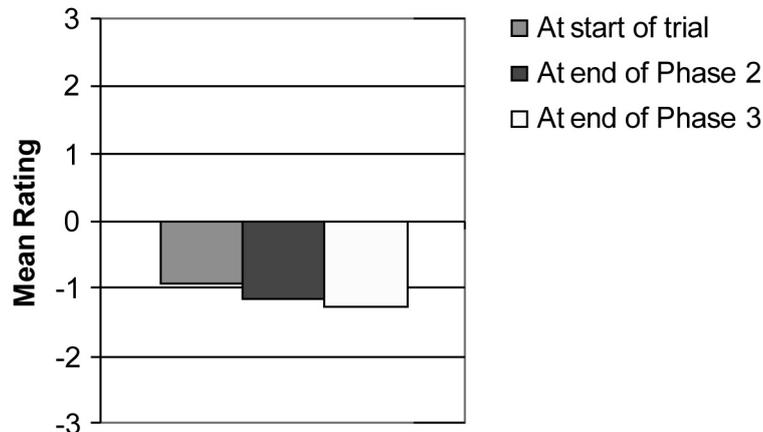


Figure 10: Mean lapse, error and violation score on Driver Behaviour Questionnaire over time

Figure 11 shows intention to speed over time. ISA reduced not only the actual propensity to speed as discussed earlier but also intention to speed. In other words use of ISA acted as a kind of vaccination against wanting to speed, and the effect persisted into the after period.



**Figure 11: Mean intention to speed**

Other attitudinal findings were as follows:

- Drivers reported that their anticipation of conflicts, attention to vulnerable road users and to speed limits increased while driving with ISA;
- Drivers disagreed that ISA decreased following distances and made them less vigilant;
- Drivers agreed that ISA created difficulties when overtaking;
- Compared to unsupported driving, ISA increased drivers' feeling of frustration and perception of risk when overtaking, when driving on motorways and when driving in fast moving traffic;
- But overall ISA decreased drivers' feelings of frustration and perceptions of risk in the majority of driving situations.

It is clear that in general the participants were not turned off by the experience of ISA, and that ISA reduced intention to speed. Overall the drivers reported an improvement in awareness and driving performance with ISA.

## ACCIDENT PREDICTION AND COST-BENEFIT ANALYSIS

In order to make any decisions about whether ISA is worth pursuing, and if so in what form it should be pursued, it is necessary to estimate how many accidents could be prevented by ISA adoption and whether there is a justification for ISA introduction in social cost-benefit terms. The procedure used had three main stages:

1. Calculating the impact of ISA in terms of changes in the distribution of speeds for roads with each speed limit (20, 30, 40, 50, 60 and 70 mph);
2. Estimating the impact of those changes in speed limit on the risk of involvement in crashes by severity (slight, serious and fatal);
3. Carrying out a cost benefit analysis, following the standard Department for Transport procedure as laid down in the COBA Manual. The steps here were to:
  - a. Predict traffic growth as laid out in DfT advice
  - b. Predict accident trends without ISA, again in line with DfT advice — this provides the “no ISA” scenario

- c. Predict the safety impact of ISA over time, based on stage 2 (the safety impact of ISA depends on the mix of ISA systems that are fitted in future years)
- d. Estimate the costs of ISA support and equipment over time
- e. Analyse the costs and benefits over the 60 year period from 2010.

The field trial data were used to estimate the changes in the distribution of speeds brought about by ISA, and, as stated above, this was done by speed limit. Speed changes with Voluntary ISA were calculated by comparing driving in the baseline period with driving in the ISA-available period. Speed changes with Mandatory (non-overridable ISA) were calculated by comparing the baseline with the ISA-available period, but using only the driving when the participants had the ISA system enabled (i.e. not overridden). For Advisory ISA, there was no empirical data on the behaviour of UK drivers. So an adjustment factor was applied to the observed driving with Voluntary ISA. This adjustment factor was obtained from the results of the French LAVIA project, where the drivers used both Advisory and Voluntary ISA. The adjustment factor consisted of the proportionate change in speed achieved in LAVIA with Advisory ISA as compared with the proportionate change in speed with Voluntary ISA (Ehrlich et al., 2006).

To estimate the effects of changes in speed distribution on crash risk, empirically-derived models from the literature were applied. There was a preference for:

- Models that fitted to data for each particular road category (urban, rural, motorway), as opposed to general models for all roads;
- Models based on UK data;
- Models based on before and after data as opposed to cross-sectional data since the before-and-after models control better for road quality;
- Models that were suitable for ISA, in that they were able to handle the change in the shape of the speed distribution when ISA curtails speeds above the limit (this is relevant for intervening forms of ISA).

Alternative combinations of models were tested in order to ascertain the sensitivity of the results to choice of models. Here the results for the “preferred” combination are presented.

A scenario-based approach was used to examine the potential of ISA. Two scenarios or visions of the future were developed for how ISA would be implemented. The first was the Market Driven scenario. Here the vision was that vehicle owners (and operators) may or may not choose to purchase and fit a commercially available variant of ISA variant, which initially tends to be Advisory ISA. The Authority Driven scenario starts with some drivers choosing to equip their vehicles with ISA (as in the Market Driven scenario). However, the Government or the EU at some point requires the fitment of Voluntary ISA on new vehicles as well as the retro-refitting of existing fleets to accelerate take-up and ensure that the full potential of ISA is realised. Eventually, once most vehicles are fitted, usage of ISA becomes compulsory so that Voluntary ISA is turned into Mandatory ISA. The scenarios were intended to be illustrative of what might happen and of how social and political decisions could affect the potential impact of ISA.

Figure 12 shows, for the Market Driven scenario, the predicted penetration of ISA in light vehicles (cars, vans and light trucks). Advisory ISA has fairly quick ramp-up, because it is just a simple addition to Satellite Navigation. By 2020, all the light vehicle fleet is predicted to have ISA, but that will almost entirely be in Advisory form. Even by 2070 Voluntary ISA will only be on half the vehicle fleet.

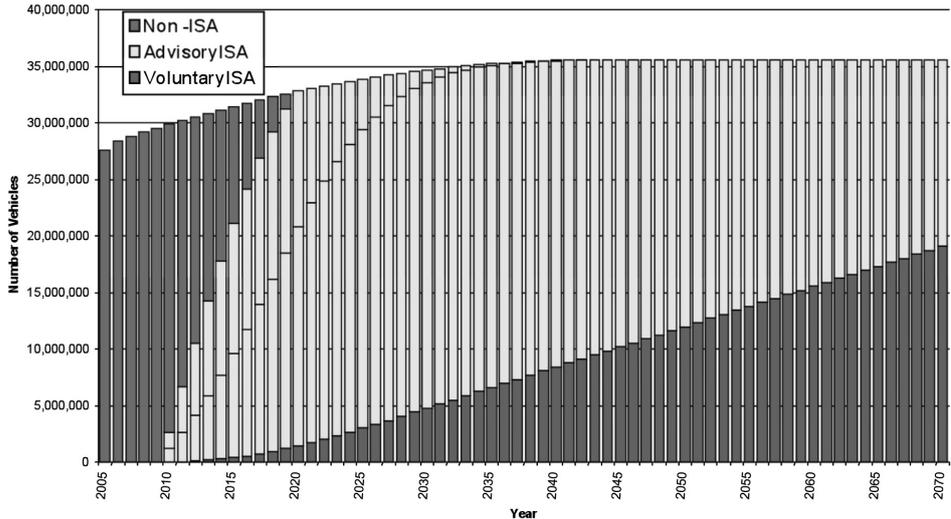


Figure 12: Predicted ISA penetration in light vehicles under the Market Driven scenario

By contrast Figure 13 shows the predicted ISA penetration in light vehicles under the Authority Driven scenario. With compulsory fitment of Voluntary ISA on most new vehicles from 2017, there is much faster penetration of Voluntary ISA than under the Market Driven scenario. By 2045, 99% of the fleet has the Voluntary system, and at that time it is envisaged that usage becomes compulsory and Mandatory ISA is thus switched on.

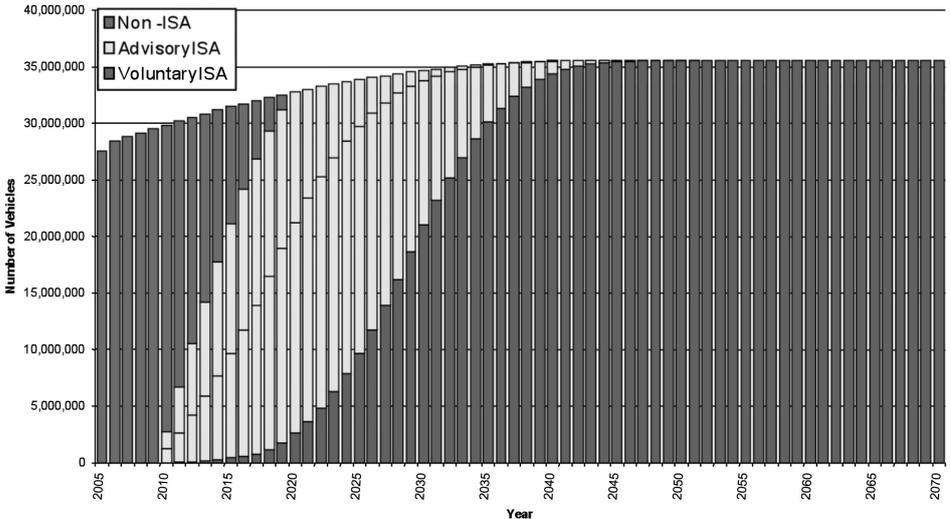


Figure 13: Predicted ISA penetration in light vehicles under the Authority Driven scenario

Figure 14 shows the predicted crash reduction over time with the Market Driven scenario, while Figure 15 shows the equivalent prediction for the Authority Driven scenario. It can be seen that the reductions obtained with the latter are far more dramatic than with the former. The step change in 2045 in Figure 15 occurs as a result of usage becoming compulsory.

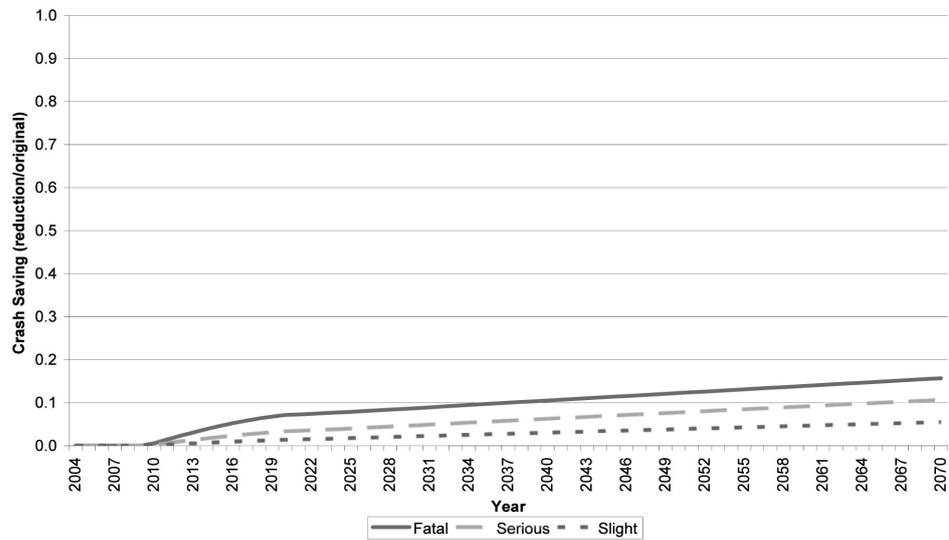


Figure 14: Crash reduction over time with the Market Driven scenario

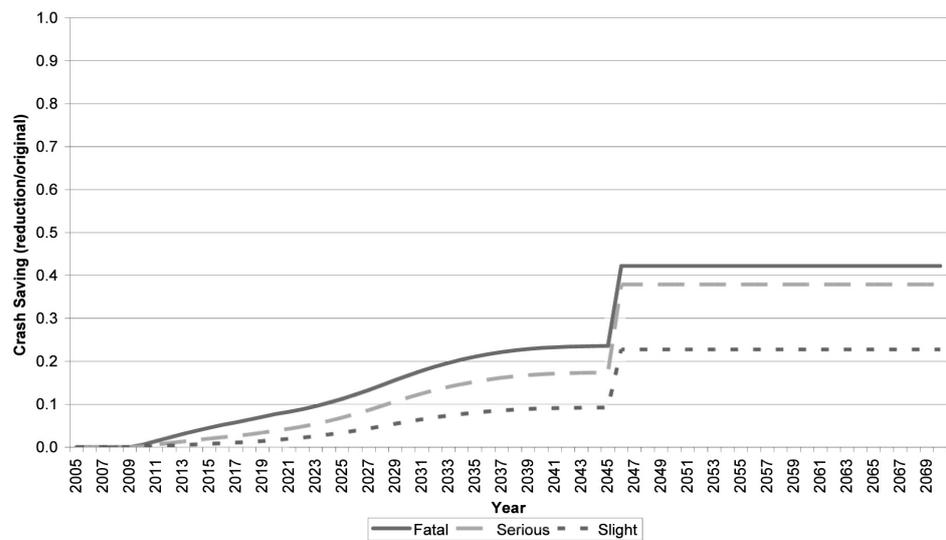


Figure 15: Crash reduction over time with the Authority Driven scenario

Table 1 compares the numbers of crashes saved under the two scenarios over the period 2010 to 2070 in a comparison of predicted outcomes. The Authority Driven scenario would have a considerable impact over the period.

Table 1: Crashes saved 2010 to 2070

Scenario	Slight Crashes	Serious Crashes	Fatal Crashes
Market Driven	3%	6%	10%
Authority Driven	12%	23%	26%

The overall benefit to cost ratios (BCRs) calculated are 1.9 for the Market Driven scenario and 3.2 for the Authority Driven scenario. In both cases almost all the costs are attributable to the in-vehicle equipment. These BCRs mean that both of the alternative futures are fully justifiable in terms of social investment, but the more forceful scenario clearly has greater pay-off.

Thus it can be seen that both scenarios are “winners”, but benefits are tied very closely to the form of ISA and the rate of adoption. The harder the push for ISA and the “stronger” the system, the greater the benefits. It should be noted that ISA can potentially deliver far more than was considered in this analysis. For example, it was assumed that, apart from the introduction of ISA, there would be no fundamental changes in the speed management regime. But ISA could deliver 20 mph zones for virtually no cost, since all that would be required would be an alteration in the speed limit map. There would be no need for all the costly infrastructure changes normally associated with 20 mph zones. ISA could also be employed dynamically, by the addition of a communications interface. This would enable dynamic speed management to be extended to the whole road network. In the long run, we might get away completely from having fixed speed limits.

## IMPLICATIONS

There are some important implications of what has been discussed here, particularly in the policy domain. We are in danger of being overwhelmed by the rate of change brought about by the introduction of new technologies into transport. There is also a need to take seriously both the complexity brought about by the range of new systems and the effects of that complexity on the driving task.

The example of texting and use of the mobile phone in the car is very interesting. It was entirely foreseeable that this would be a problem once mobile phones became common. Research on the effects of mobile phone use on driving goes back almost 40 years to Ivan Brown’s study published in 1969 (Brown et al., 1969). But we were extraordinarily slow to grapple with the problem by means of legislation. Maybe the authorities need to trust the research community a bit more, rather than reacting only when fatalities start to occur.

In road transport, we also need a more strategic approach to the promotion of beneficial technologies. It is to the credit of DfT that it funded the real-world trials of ISA, but there is still a more general need to support trials of other systems in order to validate the claimed benefits. UK participation in the current trials of vehicle-based systems funded through European collaborative research is lamentably small. We do not want to be at the mercy of technology push from the vehicle manufacturers.

We need also need a mechanism to promote take-up of systems that are shown to deliver benefits. Here Primary EuroNCAP, which has been on the drawing board for several years, could have a major role. The idea would to score vehicles on primary safety, namely their ability to avoid crashes, in addition to the current rankings on secondary safety. Both the manufactures and the public would quickly respond to a scoring system. In addition, tax incentives which are already used to encourage the purchase and use of green vehicles, could provide a mechanism to promote safer vehicles.

In road transport, we can learn lessons from aviation in terms of cooperation between stakeholders. At the moment we suffer from a disjointed and ad-hoc approach to the management of new technologies in road. There must be a better way.

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# THE MINISTER'S RESPONSE

JIM FITZPATRICK MP

PARLIAMENTARY UNDER SECRETARY OF STATE,  
DEPARTMENT FOR TRANSPORT.

Thank-you, and good evening.

It's a great pleasure to be here today, and thank you for inviting me to speak.

My apologies for not being able to stay. I can't imagine it will impact on the enjoyment of your meal. It will probably improve it!

I'd also like to thank Professor Carsten for that fascinating and enlightening look at the benefits and potential pitfalls of technology.

By way of comparison, I'd now like to talk about the wider road safety picture.

Ladies and gentlemen, we have a very good road safety record in this country, as we all know – one of the best in the world – and last year the number of road deaths fell by 226 to below 3,000 for the first time in 80 years.

However, on average eight lives are still being lost every day on our roads – each one a tragedy, and many of them avoidable. Although we are making good progress towards our target of reducing road casualties up to 2010, there are still far too many people being needlessly killed or seriously injured on the roads.

So there's no room for complacency in the drive to save lives.

Conditions on our roads are constantly changing; drivers are changing; and technology is changing.

Our response as road safety professionals must also evolve and adapt as we progress, and today I'd like to set out how we are changing the way we enforce the rules of the road.

Although successful enforcement involves a range of different aims, our main focus must be improving driver compliance with road safety laws.

That's why we have recently published a consultation about ways to improve compliance in a number of key areas: drink and drug driving, speeding, careless driving, and wearing seatbelts.

It follows up a number of key commitments from the 2007 review of our road safety strategy, and is designed first and foremost, to help the police do their job.

Only a small minority of motorists continues to break the drink-driving rules, thanks to many years of effective enforcement, stringent penalties, and hard hitting advertising campaigns.

Yet this minority of utterly irresponsible drivers still accounts for one sixth of all road deaths in this country.

These people don't care about the contempt in which they're held by the rest of us. They don't consider the potentially devastating effect, that their behaviour may have on innocent victims, and they clearly don't think that drink-driving may also destroy their own lives. They are utterly thoughtless.

So the consultation is focused on rooting them out and dealing with them. We have invited views on reducing the drink drive limit, and proposed the wider use of targeted road blocks, to catch and deter drink drivers, and to address certain procedural loopholes which currently hinder enforcement.

This week we also join forces with the police to launch the THINK! Christmas drink-driving campaign, specifically confronting young men with the bleak reality that if they drink and drive they face being

treated like any other criminal – something that few of them realise.

That means being taken down the police station, interviewed, fingerprinted, DNA and breath tested, and potentially held in a cell.

One of the biggest challenges of the next decade, will be to make speeding as unacceptable to mainstream society, as drink-driving has become. There are still far too many drivers who regularly break the limits, although I believe we are gradually winning the battle against speeding.

That process must continue, backed by speed cameras – including average speed cameras – where they are effective, by THINK! advertising, driving home the message that speeding is not only dangerous but also unacceptable, and by police officers focused on successful enforcement.

So we are consulting on introducing a higher 6-point fixed penalty for extreme speeders, with no graduation in fixed penalty fines – and we welcome your contribution to the debate.

We remain committed to speed cameras, for the simple reason, that they work. Some drivers and the media may criticise them, but people up and down the country continue to ask for speed cameras for their communities. We have always said that individual camera sites should be reviewed if they appear to be ineffective, but cameras will continue to be a crucial part of our road safety strategy.

We are particularly interested in the potential for average speed cameras to reduce casualties.

On drug driving we want to see if we can create a new offence, of driving with an illicit substance in the body, for drugs that are known to be impairing. Of course, if the proposals are to work, they need to work for the police. That means they need to be practical, accurate, and enforceable.

Practicality is also an issue with measures to tackle careless driving.

We recognise there is a burden involved in taking cases to court unnecessarily, so we therefore propose to make careless driving a fixed penalty offence.

Finally, on compliance, we have set out plans to boost the wearing of seat belts, backed by the new THINK! Campaign, launched on 3 November, which graphically shows the dangers of failing to belt up. Seat belts may be one of the oldest, and most basic safety features on a car, but wearing them on every single trip is still absolutely vital.

These measures to improve driver compliance will be backed up by a more proactive driver training and testing system.

With newly-qualified drivers and their passengers accounting for one in five of all car deaths in Britain, we are committed to reforming our driver training and testing system. Our aim is to create safer drivers for life, by creating a culture of extended and advanced training.

We are making a pre-driver qualification in safe road use, available to young people primarily aged 14-16.

This will be a 'bankable' qualification, which gives them a solid grounding in road safety, and prepares them for learning to drive.

The driving test will be revised, to place less emphasis on mechanical manoeuvres, and more on assessing the full range of candidates' skills – including their ability to drive independently, and their awareness of broader road safety issues.

We want the driving test to be a milestone towards lifelong learning, and so we will work with employers and insurers, to develop post-test courses and qualifications, that produce safer drivers.

Alongside these measures, we continue to support a range of training schemes to improve safety among different groups of road users – such as fleet drivers, hauliers, cyclists, and motorcyclists. Ladies and gentlemen, in conclusion, I am confident that the initiatives I've outlined will help us meet more demanding road safety targets in the future.

They are a response to changing road conditions, and patterns of driver behaviour, and send out a message that we will continue to adapt and fine-tune our safety programme to save lives on the road network.

That process will continue next spring when will be consulting on our post-2010 strategy. I look forward to working with PACTs and with many of you individually as the consultation progresses.

I'm sure none of us underestimates the significant challenges that we face in the future.

But equally I know that there's nothing more important than saving lives.

By working together more closely than ever before, and by specifically targeting the most dangerous road users, I am confident we can keep on reducing the death toll on our roads in the future.

Thank you for inviting me, for listening, and for all that you do.

I hope the rest of your evening goes well.

Thank you very much.

# THE WESTMINSTER LECTURES

The Westminster Lecture is an annual event in which leaders in transport safety address topics of concern to practitioners, researchers and policy makers in the field.

- 18<sup>th</sup> Professor James Reason CBE, Emeritus Professor, University of Manchester  
Recurrent patterns in transport accidents: Conditions and causes
- 17<sup>th</sup> Professor Phil Goodwin, Professor of Transport Policy at the Centre for Transport and Society, UWE Bristol, Emeritus Professor at University College London.  
Determination and Denial: The Paradox of Safety Research and Traffic Policy
- 16<sup>th</sup> Professor Ronan Lyons, Professor of Public Health, University of Wales at Swansea.  
Connecting Public Health and Transport Safety
- 15<sup>th</sup> Professor Helen Muir, Director, Cranfield Institute for Safety, Risk and Reliability.  
In times of crisis how do passengers react?
- 14<sup>th</sup> Professor David Begg, Chairman, Commission for Integrated Transport  
Transport Safety & Integration: putting the two together
- 13<sup>th</sup> Mr. Ken Smart CBE, Chief Inspector, AAIB  
Transport Accident Investigation: a question of trust
- 12<sup>th</sup> Professor Richard Allsop, Centre for Transport Studies, UCL  
Road Safety – Britain in Europe
- 11<sup>th</sup> Dr. Rod Kimber, Director Science and Engineering, TRL  
2010: Getting there in one piece
- 10<sup>th</sup> Simon Folkard D.Sc., Department of Psychology, University of Wales at Swansea  
Transport: Rhythm and Blues
- 9<sup>th</sup> Dr. Dianne Parker, University of Manchester  
The social psychology of driver behaviour: is it time to put our foot down?
- 8<sup>th</sup> Professor Frank McKenna, Department of Psychology, Reading University  
Death by Accident: the psychology of human error
- 7<sup>th</sup> Mr. Stefan Nillson, Director, Automotive Safety Centre, Volvo  
A Holistic view on Automotive Safety
- 6<sup>th</sup> Sir Alastair Morton, Co-Chairman, Eurotunnel  
There is no such thing as perfect safety in transport, but a life is a life, however you travel
- 5<sup>th</sup> Dr. Leonard Evans, Principal Research Scientist, GM R&D Centre  
Traffic Safety Measures, Driver Behaviours Responses and Surprising Outcomes
- 4<sup>th</sup> Mr. Brian O’Neil, President, Insurance Institute for Highway Safety  
Progress in Transport Safety: the US experience
- 3<sup>rd</sup> Mr. Robert Coleman, Director General, DG VII, European Commission  
Transport Safety and the EC
- 2<sup>nd</sup> Dr. Ian Johnston, Executive Director, Australian Road Research Board  
Effective strategies for transport safety: an Australian’s perspective
- 1<sup>st</sup> Dr. Jan C. Tetlow, Secretary General, European Conference of Ministers of Transport  
Transport Safety: European cooperation for the 90s

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